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ABSTRACT

This document discusses the impact of educational technologies in higher education classrooms. It offers suggestions about using technology more effectively in the classroom, and suggests ways to improve teaching through the use of technology. Teachers can develop support systems for their efforts to implement technology, and can change classroom and personal practices that will enhance their effectiveness through the use of technology. Some of what technology promises is feasible, and teachers can use these technologies creatively. Computers can help students and teachers in practical ways; however, attention must be paid to the real needs of teachers and students. This paper encourages teachers to set up their classrooms in ways that will help their teaching and make their classroom lives more efficient and effective. Specific recommendations for doing so are offered. (HB)

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Using Computer Technologies in Teaching

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Using Computer Technologies in Teaching

Introduction

This chapter discusses the impact of educational technologies in education and classrooms, offers suggestions about how teachers and students might use these technologies more effectively, and suggests strategies for implementing technology to improve teaching. In the chapter, we also offer a few ideas about how teachers can develop support systems to help them implement technology in their teaching and how they might change classroom and personal practices in ways that make it more possible for them to use technology to do their jobs better.

Our writing has assumed an optimistic stance toward using technological tools in the classrooms. We believe that at least some promises of technology are actually possible and that teachers can design creative ways to use these technologies. Our own experience and the experiences of others we have read about makes us believe that computers can help teachers and students in many practical and educational ways. Because we believe positive actions are possible, we believe our critical look at computer technology must start at the basics – by seriously discussing the importance of technological and computer literacy and by pointing out the gulf between what is and what could be, between the available and the practiced. We believe that, if computers are to be used effectively as a creative tool, more than lip service must be paid to the real need of teachers and students.

Information Age Optimism

We are told we live in an Information Age that processes information at a dizzying speed. Sadly, most of us seem to want to match the pace of our fastest computers, to live and work at the same speed as computers. This choice, among other choices we make, forces us to be increasingly dependent on high-quality, accurate information.

Now we have a problem. With computers, too much is as problematic as too little. We can almost drown in a sea of information that hits us like

waves – one ever larger than another. The information we gather, at its best, is fragmented by different formats and media, qualitatively questionable, and lives in many different physical locals at once. Accessing and using this information means more than just knowing where to find it. Finding stuff is actually the easy part. The real task is to find and use the "right stuff." To use resources effectively, we must become information literate. We must know how to, what to, when to, and even why to.

Librarians were perhaps the first to understand the change. The American Library Association's mission statement for the global information society defines 21st century information literacy as the ability to seek and effectively use information resources, including knowledge of how to use technologies and the forms in which information is stored (ALA, 1998). This definition includes asking good questions and accessing, locating, evaluating, and using information. These are good skills – helpful for making both academic and everyday decisions.

Although one can argue with the "get rich through gaining information" metaphor many technology leaders use, clearly having accurate, up-to-date information helps us become informed and intelligent. Plus, there is a huge up-side to the wide availability of information in the "Information Age." We are optimistic that teachers can make important democratic contributions to help close the gap between the "information rich" and the "information poor" as they help their students gain the ability to access, retrieve, and use information.

As we have written this chapter, we have held two educational goals in mind. First, we want to help teachers understand information literacy deeply enough to help them create classroom environments where students can become more information literate. We believe that the growth of computer technology and information services really can help students at all levels share resources, collaborate with others, and represent their ideas electronically. We also believe that, to help students use information resources effectively, teachers must create classroom environments rich in technological and information literacy infrastructures.

Second, we want to help reconcile our vocation with our world. As we look into homes and classrooms, we see that students' lives may be filled with

computer interactions, but teachers and schools have not yet come close to considering all the ways they can help students apply these technologies to their everyday lives. As a result, there remains a wide gap between what is and what could be, and between what is learned in school and how this knowledge could be applied to everyday life.

What Do Teachers Need?

We believe that information technology is more than a tool for researching, writing, and communicating with people throughout the world. It is a way of thinking about the world – a wide-ranging idea exchange of insights that influence and shape human activity on international scales. We also believe that, as schools consider distance learning and the addition of new technologies to their curriculum, ensuring students' information literacy becomes more difficult and more important than ever. To help their students, we believe teachers need to re-vision and challenge traditional classroom dynamics and relationships.

Today, there are so many different (and inexpensive) information sources that teachers and students have a difficult time choosing between the necessary and the gratuitous. School libraries have morphed into integrated high-tech centers, where resource-based learning expands and draws upon resources far beyond textbooks and where information literacy can both transcend and pull together traditional academic disciplines.

At the same time as we embrace these technologies, we cling to tradition. We hold dear the values of the disciplines and the disciplined way of knowing each represents. We believe in the values of honesty, humility, integrity, and even goodness – as hard as that is to define – in our own lives and in the curriculum we create for those we educate as teachers. We believe that we should not loot those human treasures called the disciplines. Instead, technologists, librarians, and teachers should work together to teach both disciplined content and the valuable skills of navigating through complex data bases and information resources.

Here teachers need help. Many know how to teach traditional subject area courses, but are less comfortable teaching information literacy. Teachers

already recognize their need to be lifeguards as their students swim in an ocean of information. Many teachers have already set their education sights on creating classroom environments that help students become self-sustaining seekers and users of information sources and digital libraries. If this curriculum goal can come to pass, especially in those schools where students come from disadvantaged or lower socio-economic backgrounds and where students previously have had little access to sources, the democratizing possibilities of schools will continue to live.

Curriculum in the Information Age

Curriculum planning has changed. Today's teachers are called to build seamless curricula designed to help students critically and effectively use a variety of information sources (books, journal articles, web sites maintained by strangers – even soundbytes and visuals) and medium (print, electronic, and networked digital libraries). To work well, these curricula must be user-centered and focus on the skills of locating, evaluating, interpreting, and communicating information sources rather than on technical activities.

Such comprehensive curricula should help students find and use a variety of different digital "coffers," should introduce effective search strategies and teach the tools for these searches, and should help students critically evaluate the sources and information found. Teachers should also create flexible classrooms where students can expand their learning by doing active searches, tracking new information addresses and updating old ones, and developing a personal portfolio of favorite and useful information sources.

At its simplest, creating curricula that help students understand research as information seeking and information retrieval is quite easy. Teachers already know students need practical information and literacy skills they can use in a variety of settings. A bigger problem for teachers is to create curricula suitable for students of different academic abilities, and with diverse needs, gain their own information literacy skills.

Like any curricula, good information-based literacy curricula are based on understanding how students learn, a solid pedagogical approach, and a

knowledge of how to break learning into "bite-sized" chunks students can chew on easily (Ercegovac, 1995; 1997). At the same time, good teachers always consider the needs of the students who actually use their programs. Information literacy curricula should help students learn to use practical information based on firm conceptual foundations – one of which is the recognition of working from need to search, interpret, evaluate, and use.

Teaching in the Information Age

This Information Age has a huge potential. Never before have students had such an easy time browsing and searching the world's repositories of information without having to leave their classrooms. It is not surprising that traditional geographically-confined libraries have been rapidly replaced by libraries without boundaries. What we have not figured out completely is how many new things we can introduce or accept without making our classrooms so confusing they bewitch our students.

We believe there is a way to shake hands with change without losing your soul. We also believe schools can not and should not quickly change their ideals of what counts as knowledge and who should decide what knowledge counts. Our great task as teachers remains to help our students learn to interpret the knowledge they collect and use.

The teachers we know seldom consider themselves moral authorities. However, all good teachers who use today's technologies are concerned with the ease with which untrained users can directly search sources and find, well, who knows what. Much of what they find lacks, well, refinement. But even if all the information found were of high quality, how can teachers help their students decrease their difficulty utilizing information retrieval systems and getting their heads around what they find? Furthermore, definitions of the breadth of access and acceptability of information are not universally agreeable. All these changes force us to rethink information literacy and to educate students in the lifelong quest for knowledge.

The Demand to Keep Up With Technology

We often hear the dire warning that students uneducated in the modern advances of our technological society won't be prepared for the world of the 21st century. These same warnings then compel educators to modify curriculum to reflect the pressing needs of contemporary technology. You must keep up! To remedy this "lack of preparation" and to "keep up," school technology programs have been rapidly developed to reflect the perceived needs of our technological society.

To old teachers like us, these warnings seem recycled. In the past, the push for schools to "keep up" with technology was the genesis of an industrial trades – or industrial arts – curriculum, different for young men and women. Today, "keeping up" with technology often means teaching content derived from the world of business and modern industry. We believe this is exceedingly narrow. Could it also be that the business world has an economic agenda? We hope to encourage a broad definition of technology education that encompasses holistic approaches to education; but, we do not want to dump the storehouses of humanity protected in curriculum content.

Technology education should expand the curriculum – not eradicate it. What manner of Luddite would resist the inclusion of computers and their accompanying technologies – like Internet, e-mail, and all manner of virtual communications – into school curricula. Plus, as we noted before, we believe today's technological education has the potential to democratize schools. Perhaps we will no longer "need to" stream away the intellectual "have-nots" into segregated curriculum "reservations" with different expectations of academic success. Because technology education naturally brings together the intellectual and applied experiences of students, it can help establish a place where curriculum can be integrated and commonalties explored. Technology education can enhance classroom teaching by offering teachers the opportunity to integrate areas of study and bring practical and realistic student learning into the classroom.

The Need for Computer Technology

The early 1980s echoed with reports about the sad state of North American schools. In fact, several specific agendas for renewal were outlined by a variety of education experts. Most noted the need for students to spend

more time on academic subjects. Most agreed that experts should define the courses students should take and the knowledge they should acquire. Most also stated that successful implementation of rigorous curricula needed higher quality tools and technology; if not, neither teaching nor learning would improve. Most called for an improved quality of teaching, suggesting the need for increased teacher competence. Most called for the building of classroom environments that promoted teaching and learning. Last, most cited the need for greater collaboration between schools, families, and communities. If these things happened, the reports suggested schools could again be "excellent."

As conservative as this so-called Educational Excellence movement was, few can dispute its recommendations. For example, the increased effectiveness of Canadian schools and has been linked to time on task. Canadian students attend school one month longer than US students and benefit from the increase. Who can argue with the need to improve tools and technology? Spend time on a Commodore 64 and a state-of-the-art computer and note the difference in performance of both machine and student. There is no comparison. Furthermore, all teachers benefit from professional development. Our job has not remained static and we need up-dated, both in terms of curricula and technology. Finally, what teacher would not hope to improve classroom environment and create greater community with the other publics – parents and communities? These self-evident needs can be enhanced with computer technologies.

The Promise of Computer Technology

How can learning be enhanced by the kinds of multimedia resources available over communications networks? First, on-line communication allows teachers to support and collaborate with geographically-isolated students. There are, throughout Canada and the United States, schools where students meet for instruction on their computers. Although no teacher education program we know of has a major in on-line learning, we see a future where on-line, distance schooling becomes more accessible to students and more desired by parents.

We also believe on-line communication can encourage problem-solving, creative, and critical thinking. Existing technology even holds the

possibility of helping students develop a network of their own resources – both human and knowledge-based. Teachers who engage in on-line learning are also engaging in personal professional development – often led by students. Students who work in on-line activities gain the ability to work collaboratively, particularly with peers from other schools. They also increase their problem-solving ability and often experience high levels of motivation and task involvement. Finally, working on-line naturally enhances self-evaluation skills.

Ewing, Dowling, & Coutts (1997) write that students experienced in on-line communication improve their problem-solving abilities, logical thinking skills, their abilities to act as instructional leaders, and increase their ability to act responsibility in their own learning. These same researchers suggest that teachers who work in on-line environments increase their knowledge of information and communication technologies, their understandings of new ways to set up and use classroom learning environments, and sometimes even gain a fresh approach and interest in their own learning.

Teaching With Computers: Best Practices

Thirty years ago, Bijou (1971) suggested that teachers could use computer technologies to shape classroom management by creating a technology-rich environment for students with serious behavior problems, who often disrupt regular classrooms. This has come to pass. Today, complete curricula now exist for what we call "at risk" students run by youth-serving organizations like the YMCA. Each curricula is complete with classroom materials and teaching procedures developed especially to help these students continue their schooling and, at the same time, help solve the problems of teachers whose classrooms were being disrupted. Certainly the possibility exists to use computer technology to create educational ghettos. However, what alternative exists for teachers struggling to teach classrooms that are increasingly inclusive – meaning that the range of students' learning abilities and behavior patterns are wider than ever? Computer technology offers a pragmatic solution justifiable in the face of complete educational defeat.

Constructivist teaching has become a dominant theme in educational literature in response to the positivist model of education prevalent in

schools. If classrooms are to become more constructivist, teaching practice must change. There should be less didactic teaching and more self-directed student learning.

Heflich (1996) notes that using online technologies encourages teachers to use more individualized and small group work instruction, both activities that support self-directed students. Research studies have found that access to online computer technology enhances constructivist teaching and learning and encourages the positive school climate needed for increased use of these technologies.

The use of computer technologies has a wide range and history of success. Computer technologies, if used democratically, promise to help exterminate structural racism and sexism within the schools and society. The research literature is filled with successful studies of school programs, offered in sometimes racially segregated US schools, where the student population is almost entirely black and considered economically disadvantaged and academically at-risk (Johnson and Ross, 1989).

Johnson and Ross (1989) also found that when subject area teachers combined their distinctive teaching styles and instructional methods, followed the accepted curriculum, and used computer technologies to "cover" classroom material, their teaching became increasingly effective. Some teachers creatively used the computer to reduce teacher-student ratios by creating classroom structures that, basically, kept students "busy learning" while they worked one-on-one with other students. Using the computer as a teaching aid, they provided learning experiences for the whole class while initiating the instructional benefits of small groups. Such studies of computer use suggest that elementary teachers develop their own models of teaching that use whatever computer technology they have to help increase one-on-one teaching time.

Mitchell and Williams (1993) studied differences in actual classroom behaviors in teaching with technology between novice and expert teachers. Six middle-school mathematics teachers from a large school district in a major metropolitan area received inservice training in the use of calculators, and their students were issued calculators for the school year. Teachers were categorized as experts or novices based

on their educational background and observations by a superior. Experts were more than twice as likely as novices to focus on content and process, to determine the difficulty of the task, restructure the task as needed, redirect student thinking, and check individual work. Experts praised student behavior more and corrected student performance twice as often, while novices were more apt to correct student behavior and more often seen at their own desks. Novice teachers initiated calculator use less often and were less likely to use calculators in class.

These differences in behaviors are hardly new or based on technological impacts. Good teachers have been acting like this forever. Really, only the technology has changed. Students still need to learn to communicate with others through writing and reading, to gain knowledge, critique the knowledge they find, and know how to integrate this knowledge into their lives. These are hardly new skills; only the landscape differs.

Another example of a successful computer technology project was titled "First Teachers." In this study (Samaras & Wilson, 1997), urban African-American families' met in an after school program which incorporated family storytelling and writing using computers. Here, children and their families used computers to tell, write, and illustrate stories they co-authored as they created family story albums. The study found that family-child interaction and learning were enhanced. Of course, it was no surprise that teaching styles varied greatly or that families cared deeply about their children's education. But, the researchers found that families believed computers helped them increase reciprocal helping interactions.

But, computer technology is not without critics. For example, some feminist thinkers (Bruce, et. al., 1985) suggest that computers are a "contraceptive technology," designed in normative and gendered ways. They note the responsibility of teachers to teach the basic skills of assessing technology from a feminist perspective, in ways that build the confidence of women students to use technological skills to enhance their own experiences and to evaluate those uses of technology especially relevant to them.

What Technologies Do To Us

Technologies are more than tools. They also construct the reasoning of teaching in contemporary schooling. The construction of what it means to be a teacher and what it means to be a student involves complex power relations (Qi, 1998). Schooling is not simply an institution of learning whose curriculum is established by government and then used by teachers to "teach" students. Schooling is a place where human lives are defined; and, technology is such a definer.

We are all shaped by the technologies found within our educational homes. For example, who would argue with the well-accepted fact that students who graduate with advanced degrees from universities all over the world are more thoughtful than those who do not attend post-secondary institutions. Why would these graduates be more thoughtful? Perhaps it is because they take courses in the philosophy of knowledge, or ethics, or political theory, or whatever – where they have intellectually wrestled with learned insights of genius that teach them to weigh decisions and actions. Perhaps the reason is simpler. Perhaps after four or more years of sitting in seats, screwed to the floor, silently listening to experts, and writing down what these experts say they have "learned" to be quiet – to feign consideration. The technology of the lecture hall has moulded their self-definition.

In the same way, new computer technologies reconstruct teachers and students. As yet, we can only speculate the products of such construction. However, it is possible that students who become extremely facile surfing the Net quickly will also come to define themselves in more assertive ways, be less reliant on teachers for their definition of success, and be less social – by traditional definitions. Perhaps students will be forced to become more moral and self-censoring as the ability to hide the world's evil from them decreases. We already see that computer technologies include a wide variety of self-surveillance and self-disciplining techniques that will become a natural part of the school experience.

According to Qi (1998), Michel Foucault's ideas about the construction of power suggest that computer technologies must be viewed as discourses that hold within them the possibilities of power. Foucault believes that

power is visible through a multiplicity of actions and the discourse associated with how knowledge is constructed. Following Foucault's logic, we can not simply accept computer technologies without rethinking the relationships among self, other, and institutional discourse they produce.

Teachers must always be a bit skeptical of any educational reform claiming to enhance autonomy and freedom. If Foucault is correct, those using or building curricula that further the use of computer technology should consider the models of power implicit within the use of that technology. Curriculum builders and teachers should be careful that new technologies do not "construct" teachers and students in new, un-considered ways they would later find problematic.

How Computer Technologies Shape Classrooms

Teachers who use computers must change their instructional approaches. Using computers forces teachers to focus on the structure of the information being taught, the design of the technology used to teach that information, and differences in how people learn. For example, good teachers must attend to individual abilities of students as these students interact, essentially, with a non-thinking reality. If not, computers might completely frustrate students.

Good teachers must also differentiate between the knowledge and skills that must be learned in school and the creative thinking and problem-solving abilities that must be taught so that knowledge can be learned. Computer technologies do change things! They move the focus from the specific subject area knowledge as a collection of "facts" and re-locate it on investigatory methods of solving problems and instructional research.

If a teacher is to teach students to investigate and inquire, that teacher must place the focus on the structure and organization of the investigation. The process, not the product, is key. Teachers would focus less on what subject area content students should know and more on how to **use** subject area content in relevant ways. Using technology in teaching means integrating investigatory, creative, and critical skills that **uses** subject area content in life's situations. The interaction between students, teachers, and computer technology becomes more complex, and the relationships between

academic learning and learning for everyday life and "real" work becomes more necessary.

What Do Teachers Need to Know?

Hertzke and Olson (1994) suggest that most teachers need to know "how-to" use technology and more information about available computer systems, hardware, and software. They need to understand how to match specific systems and needs, as well as how to implement technology in ways that improve teaching. Because it is new, teachers and students need support as they implement technology. But mostly, teachers need to consider how computer technologies help them attend to their students' needs to think more critically and engage in more advanced problem-solving – especially in the face of what seems to be an increasingly more complex, post-modern society.

We believe that, as computer technologies move into classrooms in a wholesale way, teachers need to hold to their fundamental ideals of education as the product of schools and learning as the process. Sometimes it seems so easy to get lost in the glitz and forget the basic reasons why children attend school and teachers teach. Teachers need to learn how to use technology to help them support students' academic and social success. For teachers, this includes training, technical support, and maintenance. The increased expansion of computer technologies begs thoughtful educators to re-think the future of education and debate what schools and teaching could become. As always, a teacher's focus is immediate and narrow – on the particular students within a classroom and how to encourage and guide these students toward academic success and good decision-making.

Integrating Computers into the Classroom

Most thinking educators (e. g. Cabot, 1998) believe that technology best helps teachers foster student learning when it is integrated into the regular curriculum; when technology complements the philosophy and practice of the teacher rather than re-shaping or re-directing it. Computer technology has changed school libraries and the way librarians work. Over the past 20 years, librarians have moved from teaching isolated library skills to

teaching integrated information skills. Eisenberg and Johnson (1996) suggest that effective integration of information skills has two requirements. First, skills must directly relate to content area curriculum and classroom assignments. Second, the skills themselves should be tied together in logical, systematic ways.

Maybe the best way to integrate computer technology into the classroom is to work in "information teams." Library specialists, computer teachers, and classroom teachers need to work together to develop curricula that include computer skills, general information skills, and content-area curriculum outcomes. One such comprehensive set of skills is titled The "Big Six Skills Approach to Information Problem Solving." This approach is one attempt to organize a patterned information literacy curriculum, information problem-solving process, and a set of skills that can act as a strategy for effectively and efficiently meeting information needs. The Big Six Skills include (1) task definition; (2) information seeking strategies; (3) location and access; (4) use of information; (5) synthesis; and (6) evaluation.

Integrating Computer Literacy into Classrooms

Teachers have many difficult responsibilities. First, they must know where their students are academically and where they need to go. This includes understanding students' special needs. They must choose the right activities and materials to teach their students, and they must create and administer the rules that govern student participation. Finally, they must mediate the academic expectations of parents and the community and adhere to the norms and rules that govern their actions as teachers.

Schools just can't add technology to classrooms and expect a quick transition. The classroom is dynamic and complex. As Sandholtz, et. al. (1997) warn us, the addition of any new technology further complicates the lives of teachers and students and presents many new questions.

Eisenberg and Johnson (1996) have written a very helpful ERIC Digest about teaching computer technology in the classroom context. They suggest that both the public and educators agree that students should be proficient computer users. In other words, students need to be "computer literate." But, it is not clear what it means to be computer literate. For

example, is a student who can beat a computer game computer literate? How about a student who can use computer-assisted instruction? Does a student who buys and sells hockey cards on eBay, or can download and create an entire music library on Napster have the skills necessary to prosper in society? Or, does computer literacy mean students can do word processing well enough to enter the workplace or a post-secondary education? As teachers, we once argued these questions more often. Today we seem to have fallen into a "wait and it will take care of itself" mentality. Is it possible that we just don't know the answers to the questions computer technologies pose?

What we do know is that, in many schools, teachers and students use computers very narrowly – like teachers from our childhood once used flash cards or worksheets. But, the computer as a tool of productivity remains sadly underdeveloped (Moursund, 1995). The computer – and other educational technologies – if they hold promise at all, hold promise when they are used to further subject area content, as tools to discover and synthesize information, and as ways to yield first-class presentations and representations of knowledge.

Not 20 years ago, students were learning "turtle logic," working hard learning to program computers to do simple things. Now we use computers like we use automobiles – fewer people know how they work "internally" but more people use them to take care of their everyday needs. Most educators believe computer skills are taught best in the context of actual work and in conjunction with the conventional, well-defined academic activities of the classroom – activities like writing, reading, and researching. What computers and computer technologies can do very well is expand and extend these activities.

Teaching Computer Technology in Context

Our reading and experience tells us that computer skills and technology should not be taught in isolation, and that separate "computer classes" do not really help students learn to apply computer skills in meaningful ways. Students sit through these classes and dutifully attend to a plethora of homogenised classroom assignments, then they go home and use computers to e-mail their friends, listen to their music, and download

information about their favorite celebrity. While these activities may be well and good, students remain ignorant (not stupid) of the wider possibilities and opportunities thoughtful teachers can give them about how to use computer technology in creative and self-educational ways.

We are not alone in calling for a re-thinking of how computer technologies are taught. There have been important recent shifts in how computer technology is approached and emphasized. But, in the everyday life of a classroom teacher, moving from using computers to skill-and-drill isolated facts to an integrated approach that uses computer technology to expand conventional school curriculum is an important step that needs a great deal of planning and effort.

Beginning slowly, in the early 1980s educators began to move away from teaching isolated "computer skills" to teaching integrated information skills. Eisenberg and Johnson (1996) state that the most successful of these attempts to integrate information skills were in activities designed around projects where curriculum is a collaboration of computer literacy skills and subject area content. Some of the best courses are the partnerships of computer and classroom teachers who together develop units and lessons that include computer skills, general information skills, and content-area curriculum outcomes. Some of the least successful integrations of information and technology are those that focus on almost meaningless "grocery lists" of isolated skills, such as knowing the parts of the computer, running computer software, writing drafts of papers using a word processor, or even searching for information on a CD-ROM database. Our point is that none of these are wrong to do; they are only fruitless when they are isolated activities.

Such "grocery list" approaches seldom help students transfer and apply skills from school to life. Instead, they address the "how" of computer use, but not the "when" nor "why." As a result, students may actually learn the skills and tools the curriculum stresses, but so what? They remain uneducated because they never learn how the skills of technology actually help them solve their own problems and complete their own work.

We believe the anxiety-mongers are wrong; but, even if they are right, they would agree with us that students need to learn to use computers flexibly,

creatively, and purposefully. Like any other students, students working with computers should be able to determine their own educational goals and be able to tell if a computer will help them reach these goals. Finally, they should be able to use computers to help them accomplish their goals. Individual computer skills take on a new meaning when integrated with personal problem-solving processes, and students develop true "computer literacy" as they genuinely apply computer skills as part of their everyday learning.

Using Computer Technology to Build Skills

Computers may be new, but the skills developed for computer literacy do, in fact, build upon traditional literacy skills students will probably use in their everyday lives – even before they graduate to life and the workplace. For example, the Internet skills of problem solving are skills most students in your class will use everyday. But, students probably will not use the following computer literacy "skills" everyday: knowing the basic operation, terminology, and maintenance of a computer; knowing how to use computer-assisted instructional programs; understanding the impact of technology on career and culture; computer programming; or using specialized computer applications like music composition software, computer assisted drawing, and drafting programs.

Listing computer skills is only a first step in insuring that students become proficient information and technology users. Teacher-supported scopes and sequences of skills, well-designed projects, and effective assessments are also critical. Such curricula hold tremendous opportunities for teachers to become vital, indispensable academic leaders in students' lives and for students to master the skills they need to thrive in an information-rich future.

Eisenberg, Johnson and Berkowitz (see Eisenberg and Johnson, 1996) have created a list of computer skills based on what they call the "Big Six Skills Approach." This list can be used as a way to organize research, and includes:

1. Task Definition: The first step in information problem-solving is to help students recognize their need for information, define the problem, and identify the types and amount of information needed.

2. Information seeking strategies: Once students have constructed the information problem, their next task is to consider where they can find information they need and develop a plan for searching.

3. Location and access: After students determine how they will find the information they seek, they must locate that information and access specific information found within individual resources.

4. Use of information: After finding useful resources, students must determine their relevance and then extract relevant information.

5. Synthesis: Students must organize and communicate the results of their information problem-solving.

6. Evaluation: To evaluate their work, students must ask how well the final product met the original goal and how efficiently the process helped them find the information they sought. Students may evaluate their own work or be evaluated by classmates, teachers, or parents.

Some technological skills and knowledge should be learned in the context of real work – as students use technology to work through assignments and information problems. For example, to increase their literacy, students should know and use basic computer terminology; they should be able to operate hardware and software; and, they should be able to do basic maintenance. Some students might also want to learn the basics of web page design and maintenance. All students become more literate as they come to better understand and articulate the relationship and impact of information technology on their careers, their society, and their own lives.

Teachers Using Computer Technology

Wiske, et. al. (1988) conducted interviews to assess how teachers were affected by the challenges and opportunities presented by computer technology. The findings drawn from the interviews suggest that

computers have a myriad of effects on teaching style, classroom management, and teachers' roles. Wiske, et. al. also suggest that when making policy about the use of computers in schools, those policy decisions should focus on the computer as an instructional tool and on building integrated systems of resources that support computer use in schools.

How Computers Have Changed Classrooms and Schools

Often people equate technology with computers, but a technology is basically a tool for doing something else. Williams, et. al. (1991) remind us that, in this sense, teachers have been utilizing technologies forever. For example, some common "ancient" technologies include the printed word, chalkboards, overhead projectors, telephones, audiotape recordings, slide projectors, VCR's – along with microcomputers, and video conferencing.

Nunes (1996) notes how technological advances, especially the Internet, have opened structural restrictions once posed on classroom education. Suddenly, students have gained almost unlimited out of body "soaring capacities" that make old structures obsolete. Students can now access a library of knowledge of unknown quality using computers chained to their classroom desks. They seldom need to shuffle off to the school's library, where a dutiful librarian laments her lack of budget as she catalogues the far-to-few books she can provide for the students of her little school.

Today's librarian faces different problems – physicality being one of the least important. Instead of lamenting too few resources, librarians may lament acting as morality police, working to create information highway check stops so that students won't get too much "rich data," if you know what we mean. Technology has changed education.

Technological innovations have done more than provide a wider range of information to students and teachers. They have qualitatively altered teacher-student relations and have cultivated a networked community extending far beyond the classroom. Imagine the multiple ways a simple tool like e-mail can supplement classroom discussion. Then imagine what capable students might do when motivated by even more complex Multi-User Dimensions (MUDs) and Multi-User Dimensions, Object Oriented

(MOOs) which allow them to create text-based "spatial" environments that allow exceedingly freer exchanges of ideas than traditional classrooms.

Each innovation brings a new set of problems and issues for teachers and schools. For example, helping students stay up-to-speed with technology takes time. Imagine, as well, the incredible critical thinking skills necessary if students are to be taught to wisely sort through the enormous amounts of information on the Internet. Technology may break down some barriers between teachers and students, but as Nunes (1996) suggests, technology has the potential to confuse work and play. It also begs the enduring question thoughtful teachers face daily: "Is it possible to give some students too much control."

The Link between Computers and Teaching

How do educational technology and teaching interrelate? We know that relationships have changed, but how should these relationships change further? Jorgensen (1981) says that, first, educators understand that technology sometimes lacks consideration toward teachers, teaching, and classroom communication processes. By this, we mean that educational technology often acts as if educational technology were the only consideration. Supporters of technology seem almost blind to the intrusive nature of technology to those historic and classic curriculum goals that have motivated schooling for at least two hundred years in North American culture. Technology's attention to the latest and the current conflicts with traditional educational goals like quality of evidence and thoughtful consideration.

Second, teachers should engage in collaborative inquiries and development with students. Today's student-teacher relationships call for co-operation and respect. In the past, relationships between teachers and students were traditionally based on status and experience. These relationships justified themselves almost more on deference than on co-operation and collaboration. Technology may have pushed teachers towards an ideological and praxeological crossroads, where differences between educational traditional and contemporary teaching beg examination and disparities between the ways teachers and students perceive each other reconciled.

The Impact of the Computer on Student-Teacher Relationships

The potential of videotape and e-mail technology for developing and delivering courses has changed. McEwan (1996) reminds teachers of their need to personally reflect on the impact of computer technology on classroom management. The question is: "How does the use of computer technology change the relationships of the classroom?" First, it calls for new power relationships between teachers and students. We can no longer assume, by virtue of experience and age, that a teacher is the most knowledgeable person in the classroom. It might well be that a student is far ahead of the teacher in areas of technological knowledge. If so, how should technological-superior students be treated? Who, after all, really knows more?

Teachers are left negotiating status, collaboratively engaging knowledge, and actively sharing power with students. Teaching, at least, demands more democratic classroom management. By this, we do not simply mean the rules of disciplined behavior in the narrowest sense of "does a student behave in class." Discipline perhaps falls back to its more classic meaning of a willed way of behavior – as in the discipline of science. And, classroom management expands its narrow sense of controlling behavior to mean the developing an ordered classroom life – as in the management of a personal stock portfolio. All in all, teachers must consider a wide array of components of individual accomplishment, knowledge, personality, and teaching style. Information technologies almost beg for qualitatively different teaching methods.

New technologies also allow teachers to create new evaluation techniques for themselves and their students. For example, teachers could videotape themselves or their students in the midst of classroom activity, using different formats for conferencing and evaluation. Such technologies offer teachers a historical log where students have opportunities to demonstrate improvement in their skills and knowledge to use learning strategies. We know that students' learning is enhanced when they can communicate using e-mail. We also know that using the Internet is a valuable aid to research. How can these two things be brought together to help students learn and teachers teach?

Those of us who engage in student-teacher e-mail relationships know exceedingly well that both the relationship and the workload is changed. Sustaining e-mail interactions with students is extremely time consuming, although it creates numerous benefits for both students and teachers. In addition, the emphasis on using technology for creating communication does carry over to the classroom, granting greater status to students, and sometimes teachers, as "technology experts" among their peers.

What Computer Skills Should Students Know?

Teachers can learn to use computers to help students with brainstorming or idea generating. Specific software exists that can help the user define or refine information problems. This includes the possibility of grass roots, action research on their classes, or having students from widely spaced geographic areas working together on assignments or projects. Such activities will undoubtedly help both teachers and students develop and expanded perspective on a topic.

To help things work effectively, teachers can help their students learn to evaluate the value of different electronic resources for data gathering -- including databases, CD-ROMs, commercial and Internet online resources, electronic reference works, and electronic information resources put out by community and government. Students should learn to apply evaluation criteria that helps them judge computerized electronic resources. They should learn to evaluate the value of e-mail and online discussion groups (listservs, newsgroups) as part of a search of current literature or in relation to information-seeking tasks. And, they should be able to use a computer to generate flow charts, time lines, organizational charts, project plans and calendars which help them plan and organize complex information problem-solving tasks.

Students should learn to use the computer resources and technologies of the school, including online catalogs and periodical indexes, full-text sources, multimedia computer stations, CD-ROMs, scanners, and digital cameras. They should then be sent out via Internet to locate and use computer resources and technologies beyond the school. Some of these include web sites housed on the different search engines; online public

access library catalogues; commercial databases and online news and magazine services; and community, academic, and government resources. Students should know the roles and computer expertise of people outside the school library who might provide information or assistance.

Because they are so cheap, and sometimes free, students should learn to use electronic reference materials like encyclopaedias, dictionaries, biographical sources, atlases, databanks, thesauri, almanacs, and other fact books. These are available on local area networks, stand-alone workstations, commercial online vendors, or the Internet. Students should be able to use the Internet or commercial computer networks to contact experts and help and referral services. Students might also learn to conduct electronic surveys conducted through e-mail, listservs, or newsgroups.

Students should be able to use electronic information systems such as indexes, tables of contents, user's manuals, graphic clues, icons, cross-references, Boolean logic, time lines, hyperlinks, and URLs -- including CD-ROMs and online databases. They should also be able to use Internet search engines like Google, Yahoo, Lycos, and WebCrawler.

Students should be able to connect and operate the computer technology they need to access information, reading manuals that help them complete these tasks. They should learn to view, download, decompress, and open documents and programs from Internet sites. They should be able to cut and paste information from electronic sources into personal documents, correctly citing their work. They should learn to use word processors to take notes. They should be able to record electronic information and track the locations of the sources – aware of proper citations, footnotes, endnotes, and bibliographies. They should learn to use spreadsheets, databases, and statistical software to process data. Finally, they should be able to analyze electronic information in the context of their work, rejecting non-relevant information.

Students should learn to classify and group information on a word processor, database, or spreadsheet. They should learn to use word processing and desktop publishing software to create printed documents, as they learn keyboard skills. They should create or use computer-generated graphics and art from electronic sources. They should be able to

use electronic spreadsheet software to create their own spreadsheets. They should learn to generate charts, tables, and graphs using electronic spreadsheets and graphing programs. They should use file management software to create their own databases, and they should learn software such as PowerPoint or HyperStudio to create electronic presentations and generate overheads. They should be able to create hypermedia productions, using digital video and audio. They should learn to create Web pages using hypertext markup language (HTML).

Students should practice using e-mail and other communications that help them share their work. They should be able to properly cite and credit electronic sources of information in footnotes, endnotes, and bibliographies. Students should learn to evaluate both the content and format of electronic presentations. They should use spell and grammar checkers to edit and revise their work. They should understand the need to act legally and ethically as they work with information technology, careful not to engage in copyright violations or plagiarism. They should use proper etiquette on e-mail, newsgroups, and the Internet.

Finally students should learn to use e-mail and online listservs and newsgroups to communicate with others about their assignments and other information-problems. Students should learn to use desktop conferencing, e-mail, and groupware software on local area networks to communicate with teachers and others about their own assignments, tasks, and information problems. Finally, they should thoughtfully consider new insights as they use electronic resources and tools.

How Teachers Can Use Computer Technology

Teachers need to understand how to use e-mail to communicate with others. Teachers might find it useful to communicate with other teachers via e-mail or online discussion groups. Teachers might participate in a variety of listservs and newsgroups. We believe that teachers have only begun to explore the kinds of co-operative activities in which they might participate, both locally and globally. For example, teachers might use desktop conferencing with their students, e-mail with other students or other teachers, and groupware (software) on local area networks to communicate with each other about assignments, tasks, and information

problems. There is no reason, for example, for teachers using the same textbook not to share tests, lesson plans, best practices and assignments, or any other possibilities that might help them "survive" more easily.

Plus, a variety of web sites collect teaching plans. Teachers should, in their leisure, visit these plans seeking good ideas from other teachers. They should also place their own best lesson plans on these web sites as a service to others. Web sites have been created by teachers' associations or universities with the specific intent to help teachers within a particular subject area. These web sites become catalogues of possible lessons to use with your own students.

We encourage teachers to consider how they can set up their own classroom lives technologically in ways that can be real helps to their teaching. One thing we often tell our undergraduate students is that one of the best things they can do for their students is to, themselves, have a life. Teachers can use computer technology to help make their lives simpler, more efficient, and much more effective. Here are some suggestions we make to teachers:

1. Buy a computer with a large storage capacity and with a big enough hard drive to "spin" quality computer programs.
2. Buy as many CDROM encyclopaedias as possible for classroom use. As we are writing this chapter, these encyclopaedias are virtually free – given rebates from manufacturers. Buy anything that is free. Whether it is last year's or not is of little consequence.
3. Find a shareware program, or buy software, that will give you a good grading program. Such programs are easy to find and can organize class grades systematically by highest class average, assignment weight percentages, etc.
4. Take an opportunity to find sources and collect good lesson plans. Don't be too greedy, and only print off those that are (1) of high quality and (2) fit your own curriculum goals.
5. Create an online community of friends who can help cut work time. Share tests and assignments, and engage in some online social experiences and therapy – without wearing other people out. Any time we can help teachers help teachers, we feel we are doing everyone – including students – a service.

6. Use your computer's hard drive to store your great lesson plans. We encourage teachers to write lesson plans carefully and keep them forever.
7. Create a test bank and add to it year by year. Add to your work weekly, updating and adding new ideas. Have students give suggestions.
8. Save everything you do.
9. Don't over search for information and don't collect stuff you will never use. If you collect it, you will have to deal with it – sometimes over and over again.
10. Always be on the lookout for good "buys" for both yourself and your students.
11. Change assignments in ways that help eliminate Internet cheating. Give different assignments, working to make certain that students can't simply download assignments. Some teachers who give the same old essay topics find that plagiarism is a problem. One way to avoid plagiarism is to ask students to synthesize and judge what they have read, not just list what they have read. Dealing in the realm of Blooms' understanding of higher-order questions helps eliminate copying.
12. Work to use word processing tools in creative ways to help students. There are a number of ways students can, for example, write more co-operatively or groups can split tasks when making presentations. Try to think through the possibilities and use them when they fit.

Conclusion

Teachers need to understand that computer technologies reshape how knowledge is constructed and taught. No doubt, things will continue to change. In just one example, your students' perceptions of life have been fundamentally altered by media. Television has disrupted students' links with the past and has made them more focussed on product instead of on process. We know that change will continue to happen.

We also know that, despite the extensive use of computers in education, we know little about the impact of computer instruction on our students. Butler & Clouse (1994) note that our educational research is simply too young to offer long-term insight into the impact computers have on the lives of teachers and students. Someday historians will document the history of technology, and we will read about how the computer changed

our lives as teachers. But, as yet, we live without the historical perspective of where technology fits into the educational process. We do not yet understand the impact of computers or the new technologies on our future. But, we are certain there are many.

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